Analysis of Smallholder Maize Farmers' Technical Efficiency in Ekiti State, Nigeria.

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Abstract: Maize is one of the most important cereal crops widely cultivated in Nigeria. Its production cannot be ignored at this time of recessionary economy. This study analyzed the productivity, and technical efficiency of maize production among smallholder farmers in Ekiti State, Nigeria. A multistage sampling method was employed to select one hundred and eighty (180) maize producing farmers for the study. Data were collected using structured questionnaires. Descriptive statistics and stochastic frontier production function were employed to describe the socio-economic characteristics and estimate the technical efficiency of maize farmers respectively. The results of the analysis showed that majority (83.3%) of the respondents were male with mean age of 49.6 years. About 89 percent were married and most were literates and had a mean household size of about 9 persons. Variables, maize farm size, value of maize seed planted and value of fertilizer used were efficiently utilized by the farmers while labour used and other capital inputs were inefficiently used in the production of maize. The MLE results revealed that technical efficiency of maize farmers varied due to the presence of technical inefficiency effect on maize production. The result of inefficiency model shows that an increase in variables, household size, cooperative society membership, extension agent visitation, farmers age and gender promote technical inefficiency while an increase in variables, marital status, educational level, credit accessibility and farming experience encourage technical efficiency. The mean technical efficiency of the maize farmers was 0.6605. This implies that if the efficiency of resources usage is increased by 33.95 percent, the maize farmers in the study area would operate on the production frontier given the existing technology. However, it is recommended that programmes that would focus on ways to attract and encourage the youths into maize production should be embarked upon by the government.
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Introduction

Maize (*Zea mays* L.) is the most important cereal crop in Sub-Saharan Africa (FAOSTAT, 2014) and it is widely grown by an estimated fifty percent of the population in Africa (FAOSTAT, 2010). It comes after wheat and rice in terms of world importance (Onuk, Ogara, Yahaya and Nannim, 2010). This crop has been of great importance in providing feed for livestock, food for man and raw materials for livestock feed mill and other agro-based industries. Maize constitutes a stable food in many regions of the world (Onuk *et al*., 2010; FAO and ILO, 1997). This is why its production cannot be taken for granted especially in a rapidly increasing population country like Nigeria.

Nigeria is yet to affirm her potential as one of the largest producer of maize in Africa despite the Federal and States Governments' initiations of many agricultural programmes tailored towards increasing productivity and efficiency of this sector. These programmes and policies put the smallholder farmers in central focus. This was due to the preponderance of smallholder farmers who represent a substantial proportion of the total farming population and produce over 90 percent of the total agricultural output in Nigeria (Ajibefun, Battese, and Daramola, 2002). Ojo (2000) found out that maize enterprise is faced with constraints like price fluctuation, low capitalization, diseases and pests, poor storage facilities and inefficiency of resources utilization.

In view of this, the technical efficiency of smallholder farmers has implication for the development of agriculture in Nigeria. Since maize is one of the important cereal crops grown by most of the smallholder farmers in Nigeria, it is therefore of importance for this study to identify the socio-economic characteristics of its growers and also there is need to estimate the growers productivity and technical efficiency.

Methodology

The study was conducted in Ekiti State Nigeria. A Multi-stage sampling method was employed to select small scale maize farmers for the study. At the first stage, three (3) Local Government Areas were selected randomly, while the second stage also involved the random sampling of 3 communities from each Local Government Area selected. The final stage involved the selection of 20 farmers randomly from

each community. In all, a total of 180 respondents were selected for the study.

Data were collected with the aid of structured questionnaire administered on the respondents.

Descriptive statistics such as frequency counts, means and percentages were employed to describe the respondents' socio-economic characteristics. The efficiency of resource use was determined by Stochastic Frontier Production Function (SFPF). This was developed independently by Aigner, Lovell and Schmidt (1977) and Meeusen and Vanden Broeck (1977) which is implicitly stated as;

$$Y_i = f\ (X_i\ \beta)\ \exp\ (V_i - U_i\ ), i = 1,2,3 \dots \dots \dots \dots N \dots \dots (1)$$

Where:

Y_i= the total output of the ith farmer,

X_i= the k X 1 vector of input quantities of the ith farmer,

β = the vector of unknown parameter to be determined,

V_i= random variables which are assumed to be $iid.N(0,\sigma_v^2)$

U_i = non-negative random variables which are assumed to account for technical inefficiency in production.

Technical efficiency of the respondents in the study area was estimated using Cobb Douglas production function of the SFPF model described as follows:

$$lnY_i = \beta o + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \dots + \beta_5 lnX_5 + V_i - U_i \dots \dots (2)$$

Where:

Y_i= Value of maize output (₦)

X_1 = Maize Farm size (ha)

X_2= Labour used (mandays)

X_3 = Value of maize seeds planted (₦)

X_4 = Value of fertilizer used (₦)

X_5 = Other capital input (₦) (depreciation of farm tools and equipment)

$\beta_0 - \beta_5$ = the regression parameters to be estimated.

$V_i\ and\ U_i$ are as earlier defined.

It was assumed that the technical inefficiency measured by the mode of truncated normal distribution (U_i) is a function of socio-economic factors (Yao and Liu, 1998) as given in equation 3:

$$U_i = \psi_0 + \psi_1 S_1 + \psi_2 S_2 + \psi_3 S_3 + \psi_4 S_4 + \psi_5 S_5 + \dots + \psi_9 S_9 \dots \dots (3)$$

Where:

S_1= Household size (number)

S_2= Cooperative society membership (1 member, 0 non member)

S_3= Extension agent visitation (number)

S_4= Farmers age (years)

S_5= Marital status (1 married, 0 otherwise)

S_6= Educational level (years),

S_7= Credit accessibility (1 access, 0 non- access)

S_8= farming experience (years)

S_9= gender (1 male, 0 otherwise)

$\psi_0 \dots . \psi_9$ = are parameters to be estimated.

Results and Discussion

Socio-economic characteristics of respondents

The result (Table 1) reveals that majority (83.3%) of the small holder maize farmers were males. This implies that maize production is a male dominated enterprise in the study area. This can be attributed to the culture of the people where men always have more right to land as a productive resource than women. Quisumbing (1994), Oladejo and Adetunji (2012) reported that there has been a great disparity between women and men in the size of landholdings. The mean household size was 9. This implies a fairly large family size which could be used as family labour in production and this would reduce the cost incurred on hired labour for farming activities. The study further revealed that most of the respondents were adults with mean age of 49.6 years. About 55 percent had farming experience of between 1 and 10 years while 45 percent had over 10 years experience. 58.8 percent made use of both family and hired labour on their farms. The result also indicated that majority (72.3%) of the respondents were not members of cooperative society. The implication of this is that few farmers would have access to credit facilities, since lending institutions prefer to give loans to cooperatives rather than individuals. It has been argued that cooperatives play a significant role in boosting agriculture. The study further revealed that

majority (92.3%) of the respondents got their planting materials (maize seeds) from their previous harvest. This is one of the characteristics of smallholders' farmers and this could limit their maize production capacity and efficiency. This findings conforms with that of Onuk, Ogara, Yahaya and Nannim (2010) in their study on the economic analysis of maize production in Mangu Local Government Area of Plateau State, Nigeria. About 52.2 percent of the farmers in the study area diversify their enterprise by not engaging in sole cropping. This may reduce their production risk and uncertainties. Mixed cropping system assists the small scale farmers to be food secured.

Table 1: Socio-economic characteristics of respondents

Variable	Frequency	Percentage
Gender		
Male	150	83.3
Female	30	16.7
Marital Status		
Married	160	89.0
Single	20	11.0
Educational Level		
None	40	22.2
Adult Education	28	15.6
Primary Education	50	27.7
Secondary Education	34	8.9
Tertiary	28	15.6
Age (years)		
< 31	8	4.4
31 - 40	32	17.8
41 - 50	66	36.7
51 - 60	48	26.7
> 60	26	14.4
Household Size		
1 - 3	9	5.0
4 - 6	51	28.3
7 - 9	55	30.6
10 - 12	18	10.0
> 12	47	26.1
Farming Experience (years)		
1 - 10	99	55.0
11 - 20	51	28.3
21 - 30	22	12.2
> 30	8	4.4
Labour Source		
Hired	50	27.8
Family	26	14.4
Both	104	58.8
Cooperative membership		
No	130	72.3
Yes	50	27.7
Source of Planting Materials		
ADP	6	3.3
Open Market	8	4.4
Previous Harvest	166	92.3
Cropping System		
Mixed Cropping	94	52.2
Sole Cropping	24	13.3
Others	62	34.5

Productivity analysis

The estimated sigma squared (δ^2) was 0.11 and statistically significant at 10 percent (Table 2). This shows a good fit and the correctness of specified distributional assumption of composite error term. In addition, the magnitude of variance ratio was estimated as 0.98. This is high, thus, suggesting that systematic influences that are unexplained by the production are the dominant sources of random errors. There was an existence of technical inefficiency among the sampled farmers. The estimated gamma coefficients showed that in the study area, there was a 98 percent variation in the output of maize due to differences in their technical inefficiencies.

There was a positive relationship between maize farm size (X_1) and the value of maize output(Y) in the study area (Table 2). This implies that the larger the maize farm size, the more the value of maize output and vice versa. The coefficient was significant at 1 percent level. The magnitude and sign of the coefficient of variable maize farm size showed that the production of maize experienced decreasing positive returns to farm size and hence land as an input in the production process was efficiently allocated by the maize farmers.

The coefficient of labour used (X_2) was negative. This implies that value of maize output in the study area would decrease with an increase in labour used. Also, the coefficient of this variable X_2 was statistically significant at 5 percent level of significance. The elasticity of production of labour used showed decreasing negative returns. This implies that labour was in the irrational stage of resource allocation.

The value of maize seed planted (X_3) was positive and significant at 1 percent. This indicates that an increase (decrease) in this variable X_3 would lead to increase (decrease) in the value maize output (Y) in the study area. The X_3 production elasticity of 0.27 indicated that the use of this variable was efficient in the process of production.

The partial elasticity of the value of maize output (Y) with respect to the value of fertilizer used (X_4) was 0.27. This shows that X_4 was positively related to the value of maize output in the study area. This implies that when X_4 is increased, there would be an appreciable increase in Y and vice versa. This corroborates the findings of Oluwatusin (2011) which established a positive coefficient for fertilizer use among yam farmers in Nigeria. The Coefficient of X_4 was however significant at 1 percent level. The implication of this result is that, maize farmers used fertilizer efficiently because the elasticity of production of fertilizer showed positive returns.

There was a negative relationship between other capital input (X_5) and the value of maize output of maize. This implies that one naira increase in X_5 would lead to ₦ 0.27 decrease in Y and vice versa. The coefficient was statistically significant at 5 percent level. Variable X_5 was not efficiently used because the estimated coefficient showed decreasing negative returns and hence its allocation was in the irrational stage of resource allocation.

In table 2, when inefficiency model estimated is considered, the estimated coefficient for household size (S_1) was positively and insignificantly related to the technical inefficiency. This implies that increase in household size would cause an increase in the technical inefficiency and this will lead to decrease in the technical efficiency which would cause a decrease in productivity. This result is not in line with the work done by Dimelu *et al*., (2009) that large household size increases farmer's productivity. This may be so when the resources meant for production are channeled to households' upkeep.

Cooperative society membership (S_2) was positively and insignificantly related to the technical inefficiency. This shows that membership of co-operative society leads to increase in technical inefficiency which would cause decrease in technical efficiency and reduction in productivity.

Surprisingly, coefficient for extension agent visitation (S_3) was positively and significantly correlated to technical inefficiency. This implies that as visitation of extension agents increases technical efficiency decreases and this leads to a decrease in productivity. The apriori expectation is that extension visitation should increase farmer's efficiency. This indicates that the knowledge on maize technologies extended to the farmers by the extension agents has negative influence on their technical efficiency. This may be as a result of poor quality extension services rendered to farmers due to non availability of technically qualified extension staff or farmers do not put to practice what is being taught by extension officers (Kibirige, 2013).

Estimated coefficient for farmers age (S_4) was positive. This implies that as farmer's age increases, his technical inefficiency increases and hence technical efficiency and productivity also decrease. This is an indication that older farmers are less technically efficient when compared with their young counterparts. This corroborates Okoye *et al*., (2007) who found out that ageing farmers are less energetic to farm work.

Coefficient for marital status (S_5) was negatively related to technical inefficiency. This implies that marriage leads to farmers being less inefficient, more efficient and productive. It shows that married farmers are more responsible and efficient in production.

Educational level (S_6) was statistically significant at 5 percent level and negative. This shows that the

more the year the farmer spent in formal schools the less the technical inefficiency and more the productivity. This is an indication that the farmer's level of inefficiency decreases as he/she acquires more education in the study area. This is in accordance with the apriori expectation that when educational level increases, efficiency and productivity also increase.

Credit accessibility (S_7) was negative and significant at 10 percent level. This implies that accessibility to credit makes the farmers less technically inefficient and more technically efficient and productive. This may be due to the fact that accessibility to credit facility helps the farmers to purchase the needed factors of production.

The estimated coefficient for farming experience was negative and significant. This shows that the more the farming experience, the less the technical inefficiency and the more the technical efficiency and productivity. This implies that experienced maize farmers are more productive and efficient. This result corroborates the findings of Oluwatusin (2011) that the farmers with more experience tend to be more efficient in production because with time new skills are developed. Also, increase in year of cultivation may also enhance critical evaluation of the relevance of better production decision, including optimal use of available farm inputs. Estimated coefficient for gender was significant at 5 percent level. It was positively related to technical inefficiency. This implies that in the study area, men are more inefficient and less productive than their women counterparts.

Table 2: Maximum likelihood estimates for the parameters of the stochastic frontier production function

Variable	Coefficient	Standard error	t-value
constant	0.8971	0.8075	1.1109
Maize farm size(Ha)(X_1)	0.5013	0.2215	2.2632***
Labour used (mandays) (X_2)	-0.1539	0.0587	-2.6218**
Value of maize seeds planted (₦) (X_3)	0.2739	0.0554	4.9440***
Value of fertilizer used (₦) (X_4)	0.2727	0.0633	4.3080***
Other Capital Input (₦) (X_5) (depreciation)	-0.1804	0.0813	-2.2189**
Inefficiency model			
Constant	-0.2051	0.1528	-1.3425
Household size (S_1)	0.0386	0.1498	0.2576
Cooperative society membership (S_2)	0.1837	0.5839	0.3147
Extension agent visitation (S_3)	0.1114	0.0612	1.8202*
Farmers age (S_4)	0.1743	0.1103	1.5802
Marital status (S_5)	-0.1714	0.6694	-0.2559
Educational level (S_6)	-0.7156	0.3432	2.0850**
Credit accessibility (S_7)	-0.6114	0.3541	-1.7266*
Farming experience (S_8)	-0.6114	0.2812	-2.1742**
Gender (S_9)	0.5511	0.2786	1.9781**
Variance Parameter			
Sigma Squared (σ^2)	0.1085	0.0583	1.8610*
Gamma (γ)	0.9769	0.1578	6.1907***
Log likelihood function	117.8840		

*,**and *** significant at 10%, 5% and 1% respectively

Technical Efficiency of maize farmers

Table 3: Distribution of respondents by technical efficiency

TE	Frequency	Percentage
≤ 0.30	9	5.0
0.31 - 0.40	10	5.6
0.41 - 0.50	16	8.8
0.51 - 0.60	30	16.7
0.61 - 0.70	58	32.2
> 0.70	57	31.7
Minimum	0.1048	
Maximum	0.8553	
Mean	0.6605	

Table 3 shows the distribution of respondents by their technical efficiency. Just 5 percent of the respondents had their technical efficiencies (TE) equaled to 0.30 or less, while 5.6 percent had theirs between 0.31 and 0.40. Also, those with TEs between 0.41 and 0.50 were 8.8 percent. The majority (80.6%) of the maize farmers in the study area had TEs of 0.51 and above.

The summary of predicted technical efficiency obtained using the estimated Stochastic Frontier model (Table 3) showed that the minimum and maximum technical efficiencies (TE) of the maize farmers were 0.10 and 0.86 respectively while the mean was 0.6605. This shows that if the efficiency of resources usage is increased by 33.95 percent, the maize farmers in the

study area would operate on the production frontier given the existing technology.

The implication of the finding is that maize farmers in the study area are averagely efficient in using resources at their disposal.

Conclusion and Recommendations

The study analyzed the technical efficiency of maize production among small holder farmers in Ekiti State, Nigeria. A multistage sampling technique was used to select 180 farmers in the study area. Data were collected and subjected to descriptive statistics and stochastic frontier production function analysis using frontier 4.1 according to Battesse and Ceoli (1995).

The research revealed that most of the respondents are male and married with large family. They are well educated and experienced with mean age of 49.6 years. Most of them are not members of cooperative society. The main source of planting materials is the previous harvests and most of them practice mixed cropping.

Variables, land (maize farm size), seed planted (value of maize seed planted) and fertilizer (value of fertilizer used) are efficiently utilized by the farmers while labour (labour used) and other capital inputs are inefficiently used in the production of maize. The MLE results revealed that technical efficiency of maize farmers varied due to the presence of technical inefficiency effect on maize production. The result of inefficiency model shows that an increase in variables, household size, cooperative society membership, extension agent visitation, farmers age and gender promote technical inefficiency while an increase in variables, marital status, educational level, credit accessibility and farming experience encourage technical efficiency.

The minimum and maximum technical efficiencies (TE) of the maize farmers in the study area are 0.10 and 0.86 respectively while the mean is 0.6605. This shows that if the efficiency of resources usage is increased by 33.95 percent, the maize farmers in the study area would operate on the production frontier given the existing technology.

In order to increase the technical efficiency of small scale maize farmers, the following recommendations are suggested:

- Communities should be gender sensitive and give priority to women in the area of farm land allocation for maize production since women are more efficient in resources allocation.
- The extension agents should be empowered so as to improve the quality of information extended to the farmers.
- Since the study shows that an increase in the age of the farmers would lead to decline in their technical efficiency, programmes that would focus on ways to attract and encourage the youths into maize production should be embarked upon.
- Also, since credit accessibility promotes efficiency and productivity, policy that will make financial institutions give credit facility at one digit interest rate to small scale farmers should be formulated.

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